REMARKS

Claim 1 has been amended in order to more clearly point out the subject matter that Applicants regard as their invention. As such, claims 1-20 are presently pending.

The Examiner rejected claims 1-20 under 35 U.S.C. 103(a) as being unpatentable over Keskar et al in view of Gottzmann et al. Applicants' invention as recited in amended claim 1 is a method of producing hydrogen in which a heated oxygen-containing feed stream is separated in an oxygen transport membrane to produce an oxygen permeate. The oxygen permeate is reacted with a hydrocarbon contained within a hydrocarbon-containing feed stream and steam in partial oxidation and reforming reactions to produce a crude synthesis gas. Hydrogen is separated from the crude synthesis gas in a hydrogen transport membrane to produce a hydrogen-depleted crude synthesis gas and a hydrogen permeate. The heated oxygen-containing feed stream is formed by combusting a stream of the hydrogen-depleted crude synthesis gas in the presence of the oxygen-containing feed stream. Although the use of the hydrogen-depleted crude synthesis gas in such a manner does not allow for recovery of additional hydrogen or other use of the same, it does allow for hydrogen generation to be effectuated by a compact installation that does not use many heat exchangers. In this regard, among other patentably distinguishing features of Applicants' invention, none of the references cited by the Examiner, either individually or taken as a whole, recite or are even remotely suggestive of forming the heated oxygen-containing feed stream in the manner set forth in amended claim 1.

As the Examiner points out, Keskar et al discloses a process for producing synthesis gas and a hydrogen in which an oxygen transport membrane reactor is used to separate oxygen from a heated oxygen-containing feed to form an oxygen permeate which in turn is reacted with separated oxygen. The fuel and steam produce a synthesis gas by partial oxidation and optionally steam reforming reactions. It is important to note that this type of reactor is an autothermal reactor in that the heat generated from the partial oxidation reaction balances the heat consumed in the endothermic steam reforming reaction. See for instance Keskar et al, lines 37-42.

As is also noted by the Examiner, Keskar et al does not disclose that a stream of the hydrogen-depleted synthesis gas can be combusted in the presence of the oxygen-containing feed stream to heat the same. On this point, Keskar et al not only teaches that the hydrogen-depleted synthesis gas stream, or as referred to in this patent, the carbon monoxide stream 18 is passed into a heat exchanger 3 to indirectly heat the incoming

oxygen containing feed 1, but also, that further hydrogen can thereafter be separated from the carbon monoxide stream 18 in a separator 19. As such, the teachings in Keskar et al with respect to the combustion of the hydrogen depleted retentate are exactly opposite to those contained in Applicants' invention as recited in amended claim 1.

LaPierre et al discloses a method for producing hydrogen in a reforming reactor using a hydrocarbon stream and water vapor stream as reactants. A hydrogen stream is purified to form a retentate stream which is combusted to provide heat to the reforming reaction. However, the LaPierre et al reactor, unlike the present invention or the Keskar et al reactor for that matter, is not an autothermal reactor but rather, purely, a steam methane reforming reactor. As specifically stated in LaPierre et al, column 7, lines 8-10, "The reforming reaction (after steady-state is reached) is preferably conducted in atmospheres substantially free of oxygen and nitrogen..."

The foregoing is also borne out in the figures. For instance, in Figure 1 a water stream 23 is heated and introduced into the reactor along with a hydrocarbon-containing stream and a retentate recycle stream. There is no oxygen or oxygen-containing stream introduced because partial oxidation reactions are not contemplated in the type of reactor being discussed in this reference. As such, all the heat transfer is indirect. For instance, with reference to Figure 1, a conduit 13 surrounds the reforming reaction and receives a combusted gas stream 100b from the combustor and is discharged as a stream 100c. Combusted gas stream 100a is used to vaporize the pressurized hydrocarbon-containing feed 21 and water stream 25 within vaporizers 87 and 88. Hence, while this patent utilizes a hydrogen depleted retentate, it contains no teaching or even the remotest of suggestions that the retentate can be mixed in with an incoming oxygen-containing feed and combusted to supply a heated oxygen-containing feed. As such, Applicants disagree with the Examiner that such combination of references make out a prima facie case of obviousness. In any event, given the amendment to claim 1, which requires that the stream resulting from the step of combusting a stream of the hydrogen-depleted crude synthesis gas in the presence of the oxygen-containing feed stream is to be employed as the "heated oxygen-containing feed stream", it would appear that this ground of rejection is in any case rendered moot.

With respect to the rejection of claims 1-20 under 35 U.S.C. 103(a) as being unpatentable over Keskar et al in view of LaPierre et al further in view of Gottzmann et al Applicants submit that Gottzmann et al adds nothing that would render Applicants' invention as recited in amended claim 1 unpatentable. Applicants agree that Gottzmann

et al does disclose a process in which methane is used to form a synthesis gas through the use of an oxygen transport membrane reactor utilizing partial oxidation and steam reforming reactions. Furthermore, Gottzmann et al, as noted by the Examiner, teaches in-line combustion of the oxygen-containing stream to heat the same. However, it does not teach recirculation of a hydrogen-depleted crude synthesis gas stream to serve as the fuel for combustion because it does not produce a hydrogen completed synthesis gas stream in the first instance.

Applicants submit that their invention as recited in amended claim 1 is not rendered obvious by such rejecting combination in the first instance. Keskar et al teaches using the hydrogen depleted retentate to heat the incoming oxygen-containing feed and as a further source of hydrogen. Hence, it directly teaches away from using the hydrogen depleted retentate as any source of fuel in which the hydrogen would be lost. It therefore can be seen that the modification proposed by the Examiner in view of Gottzmann et al, namely an in-line combustion of the oxygen-containing feed, is simply a reconstruction of the prior art prompted by the teachings of Applicants' invention and is improper. Furthermore, LaPierre et al is not suggestive of using the hydrogen depleted retentate as a fuel for in-line combustion in that such reference does not disclose an autothermal reactor in which a heated oxygen-containing stream is used, but rather, an endothermic steam methane reforming reactor that requires external heating that is supplied by combusting a hydrogen depleted retentate. Applicants submit that the only teaching or disclosure of using the hydrogen depleted retentate as a fuel for in-line combustion of the oxygen-containing feed to an autothermal, oxygen transport membrane reactor is supplied by Applicants' invention and not by the references. Hence, Applicants' invention as recited in amended claim 1 is not rendered obvious and unpatentable by the Examiner's rejecting combination.

Since amended claim 1 is allowable, Applicants submit that the dependent claims 2-20 should be allowable on the same basis.

The Examiner next rejected claims 1-20 as being indefinite under 35 U.S.C. 112, second paragraph. Applicants submit that in light of the amendments to claim 1, this ground of rejection is hereby rendered moot.

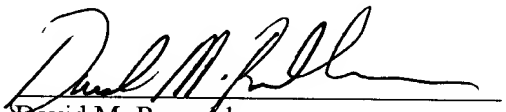
The other references of record have been reviewed, but it is not believed that such references rendered in the presently pending claims unpatentable.

Applicants are aware that this response is being made within the first month. Therefore, a petition together with directions to charge our deposit account no. 16-2440 is

hereby attached in the amount of $110.00. In the event that the petition and charge order account direction, become separated from this response, Applicants hereby make said petition and charge order account direction herein.

In view of the amendments to the claims and the remarks set forth above, Applicants request reconsideration of the rejection and allowance of all presently pending claims. Since the claims are in condition for allowance, prompt and favorable action is hereby solicited.

Respectfully submitted,



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